

RADIATION SCIENCE TODAY

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1. Opinion Article

Is antioxidant property, a better approach to find a radioprotector?

Nazir M. Khan* and T. B. Poduval

Immunology and Hyperthermia Section, Radiation Biology and Health Sciences Division Bhabha Atomic Research Centre, Trombay, Mumbai–400 085, India *Email: nazirkhan29@gmail.com

Ionizing radiation is commonly used as a treatment modality for a variety of cancers. Besides killing cancer cells it also causes damage to the surrounding normal tissue. It has been shown to alter the various biomolecules of cell and lead to cellular damage. The deleterious effects of ionizing radiation are known to be mediated through the direct

deposition of energy to critical biological molecules, and indirectly through the generation of highly reactive free radicals [1]. Indirect effect of ionizing radiation mediated through free radicals mainly reactive oxygen species (ROS) is known to

"Whether ROS scavenging is the only way to protect radiation insults?"

account for approximately 75% of the damage to cells [2]. ROS including superoxide radical $(O2^{\bullet-})$, hydrogen peroxide (H_2O_2) , and hydroxyl radical ($^{\bullet}OH$) are formed during radiation exposure of cells due to radiolysis of water, the most abundant intracellular component. These oxygen intermediates cause extensive cellular damage such as nucleic acid strand scission, modification of polypeptides, and lipid peroxidation [2]. DNA forms the primary target of radiation damage and membrane the alternate target [2].

Since ROS are major contributor of radiation injury, antioxidative agents having free radical scavenging ability are the better candidates to protect against radiation damage [1]. The most effective radioprotective drug developed to date, and the only agent approved by the FDA, for use during radiotherapy is amifostine (S-2-[3-aminopropylamino] ethylphosphorothioic acid) [2]. Other nonprotein thiols possessing antioxidative properties that are currently approved for clinical use include: captopril ([S]-1-[3-mercapto-2-methyl-1-oxo-propyl]-l-proline), mesna (sodium-2mercaptoethane sulfonate), and N-acetyl-l-cysteine (NAC) [2]. Several phytochemicals having antioxidant properties (viz. vanillin, troxerutin, 5-aminosalicylic acid, orientin, vicenin etc.) and plant extracts (viz. Podophyllum hexandrum, Pilea microphylla (L.) etc and sulfhydryl antioxidants like cysteine, cysteamine, cystamine, aminoethylisothiourea dihydrobromide, and mercaptoethyl guanidine have been evaluated for their radioprotective properties *in vitro* and *in vivo* models [1].

Do all the antioxidants protect against radiation injury? Whether ROS scavenging is the only way to protect radiation insults? Whether ROS scavenging alone is able to protect against radiation toxicity? In spite of having strong antioxidant property, why these phytochemicals, synthetic chemicals and plants extract failed to reach the clinical levels? Why radiation biologist failed to translate the antioxidative radioprotectors from bench to bed side? One probable answer to all these burning questions is that scientists have too much focused on antioxidant properties of molecules to develop a radioprotector. If antioxidant property alone is responsible for radiation protection, unconjugated bilirubin (UCB) would have been best radioprotector. UCB possess 10,000 time better antioxidant property than that of GSH, which is considered as major antioxidant and cytoprotector of body and also possessed radioprotective ability [3].

UCB is a linear tetrapyrole, formed by endogenous degradation of heme and considered as one of best known antioxidant of body [4]. In spite of having such strong antioxidant property, recent studies from our laboratories showed that UCB at clinically relevant concentration and relevant UCB/BSA molar ratio, induced immunotoxicity via activation of p38MAPK-CD95/Bax-Caspase pathway [5]. Further our study demonstrated that UCB pre-treatment potentiated the deleterious effects of radiation in various radiosensitive immune cells like lymphocytes, macrophages and bone marrow cells [5]. UCB pre-treatment of mice potentiated whole body irradiation (WBI) induced apoptosis and decreased WBI

induced loss of functional response of cells various immune leading to potentiation of immunosuppression and infection susceptibility caused by WBI. In an acute bacterial peritonitis model, it was found that UCB pre-treatment of mice significantly increased WBI induced proinflammatory cytokines (TNF-alpha, IFN-gamma and IL-1 beta), nitric oxide and peritoneal bacterial load resulting in increased infection and death [5]. UCB pretreatment of mice worsened the radiation effects and further deteriorated the host condition.

"..authors suggest that antioxidant property may be one of the aspects responsible for radioprotection, but it is certainly not the sole factor accountable for protection against radiation injury."

In view of these results, authors suggest that antioxidant property may be one of the aspects responsible for radioprotection, but it is certainly not the sole factor accountable for protection against radiation injury. Further our recent study demonstrated that even well known pro-oxidant like H2O2, diethylmaleate, t-butyl hydroquinone, 1,4 naphthoquinone offer a high degree of radioprotection in murine model via activation of prosurvival pathways [1]. These results further supported our conclusion.

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- Kunwar, A.; Bansal, P.; Kumar, S. J.; Bag, P. P.; Paul, P.; Reddy, N. D.; Kumbhare, L. B.; Jain, V. K.; Chaubey, R. C.; Unnikrishnan, M. K.; Priyadarsini, K. I. In vivo radioprotection studies of 3,3'-diselenodipropionic acid, a selenocystine derivative. Free Radic Biol Med 48:399-410.2010
- 3. Thomas W. Sedlak, Masoumeh Saleh, Daniel S. Higginson, Bindu D. Paul, Krishna R. Juluri and Solomon H. Snyder. Bilirubin and glutathione have complementary antioxidant and cytoprotective roles. PNAS 31, 2009 vol. 106 no. 13 5171-5176.
- 4. Khan, N. M.; Poduval, T. B. Immunomodulatory and immunotoxic effects of bilirubin: molecular mechanisms. J Leukoc Biol 90:997-1015; 2011.

5. Khan, N. M.; Poduval, T. B. Bilirubin augmentes radiation injury and leads to increased infection and mortality in mice: Molecular mechanisms Free Radic Biol Med, 2012(In Press).

About authors:



Mr. Mohd. Nazir Khan has recently submitted his PhD thesis in Life Science at Bhabha Atomic Research Centre under aegis of Homi Bhabha National Institute, Mumbai. He joined BARC after graduating from 51st batch of training school and 2nd Batch of HBNI. His research interest include role of cellular redox homeostasis in the modulation of radiation injury and immune responses. He is also involved in the investigation of anticancer, anti-inflammatory and immunomodulatory properties of various natural products.



Dr. T. B. Poduval is currently Head of Immunology and Hyperthermia Section, Radiation Biology and Health Sciences Division, BARC. His research interest include identifying the novel biological response modifiers especially of endogenous origin (L-Arginine, Bilirubin) for the treatment of critical injury like Heat Stroke, Septic Shock and Acute Radiation injury. He is involved in the development of new biomedical techniques, especially using immunological techniques.

2. **BIOGRAPHICAL NOTE**

Marie Curie-The Woman who Changed the Course of Radiation Sciences

Marie Skłodowska-Curie (7 November 1867 - 4 July 1934) was a French-Polish physicist and chemist famous for her pioneering research on radioactivity. She was the first person honored with two Nobel Prizes-in physics and chemistry. She was the first female professor at the University of Paris, and in 1995 became the first woman to be entombed on her own merits in the Panthéon in Paris. Marie Curie was one of the most important woman scientists in history, and she was one of the most influential scientists' man or woman of the 20th century. Curie postulated that radiation was an atomic property, a discovery that has led to significant scientific developments since. She was also the first person to use the term radioactivity. Her perseverance led to the discovery of two new



elements, polonium and radium.

Marie Curie (1867-1934)

A concise look at the life of one of the most famous female scientist gives us insight into her struggle with the demands of family and the social responsibility associated with her groundbreaking work in physics and chemistry. The youngest daughter of educated Polish

"A concise look at the life of one of the most famous female scientist gives us insight *into her struggle with the demands of* family and the social responsibility associated with her groundbreaking work in physics and chemistry."

parents, during an era when Russian control clamped down on the slightest hint of Polish nationalism, Marie learned early that you had to fight, often secretly, for what you believed in. With a childhood marred by the deaths of her mother and sister, these early lessons made this stubborn woman determined to aet an education at a time when women were not encouraged to attend universitylet alone to study science.

Marie Curie had 4 siblings. They were- eldest, Zofia (nicknamed

Zosia) born in 1862. The boy Josef (or Jozio), was one year younger than Zofia. Then there were two little girls, Bronislawia (Bronia, 1865) and Helena (Hela, 1866). All had fair hair and were lively children. On November 1867, the youngest daughter (Marie Curie) was born. Her parents called her Maria Salomea. Like other children, she was also given a nickname, 'Manya'. Maria's parents were interesting and intelligent people. Her mother was a devout Catholic, but father, Wlawdislaw Slodowski was not so religious. He was a scientist and a teacher of physics. Both parents came from a family of high social standing, although they were never wealthy.

Marie Curie suffered great sadness and hardship in life. She was a very courageous woman who lost one of her sister and her beloved mother at the age when she had just started to grow. She suffered greatly from the loss of a mother's love at such a tender age. But not losing hope completely, she still tried to be happy by involving in other activities, mainly studies. Even worse, on 18 April 1906, his husband was killed in an accident. His husband had been a great support to her in all her lab experiments and findings. Thus, it was obvious that she missed him badly. It is hard to imagine Marie's grief when Pierre was killed.

But soon her determination changed her grief into desire for finding more in science. She was able to work so much even after having 2 children, Irene and Eve by this time. Leaving them to a Governess, she would go to her work. Later her daughter also won a Nobel Prize along with her husband, Frederic for their work in chemistry. Even by such conditions in life, she never lost sight of her dream. She was driven by the hope of science and progress, in hard work, education and helping others. Thus, her life definitely teaches us the lesson of Determination & Self-Confidence.

With hard work, she & husband Perry were able to discover 2 new elements-radium and polonium. Soon, other laboratories too had started to conduct searches on radium. Marie had set up a system of certification for them. In 1910 she was able to isolate radium in the form of a metal. Radium was also a valuable research resource that Marie used for medical purposes during the World War I (September 1914) as a source for x-rays. She constructed a X-ray machine on a truck, which she would take rounds for diagnosing war victims, which would help doctors for further treatment. By this time, construction of the Radium Institute in Paris had begun and she was made its Director. In 1933 Marie travelled to the French Alps on a sanatorium as she was suffering with severe anemia. Feverish and weak, she died on 4 July, 1934.

Marie Curie was the only woman to receive two Nobel Prizes for science, the first woman to study physics at the Sorbonne and she graduated first in her class. She inspired

"Marie Curie was the lady who changed the course of radiation sciences; of course her place in the history of science is lighthouse especially for women scientists." other young female scientists to follow in her footsteps. In 1943, a film was made of her life that inspired many young girls to take up science. The Panthéon in Paris is an impressive memorial building, а memorial of France's greatest men only before that. From 1995, because of Marie Curie women too placed in

memorial. Marie Curie was the lady who changed the course of radiation sciences; of course her place in the history of science is lighthouse especially for women scientists.

by Aradhana Pandey Class-X, Atomic Energy Central School No.-2 Anushakkti Nagar, Mumbai 400 094

3. FROM ARCHIVES OF RADIATION SCIENCES

Paper: The inactivation of dilute solutions of crystalline trypsin by X-radiation. II Effects of enzyme concentration, medium, pH and temperature

Source: J Gen Physiol. 1955 May 20; 38(5): 581–598.

(http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2147502/pdf/581.pdf)

Authors: Margaret R. McDonald

Laboratory: Laboratories of the Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, Long Island

Highlights of the paper

The present paper describes about the inactivation of proteolytic activity of crystalline trypsin by X-ray, which an exponential function of the radiation dose in different pH conditions. The amount of inactivation obtained with a given dose of x-rays depends on the pH of the solution being irradiated and the nature of the solvent. It was interesting to observe that buffers such as acetate, citrate, borate and barbiturate, and other organic molecules such as ethanol and glucose, in concentrations as low as 20 μ M, inhibit the inactivation of trypsin by x-radiation.

Significance of the paper

This paper is one of the seminal papers investigating inactivation of enzyme after X-ray radiation in various pH and buffer conditions.

by

Badri N. Pandey

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Note: Interested readers may submit similar articles. This column is aimed to highlight the salient points and significance of seminal research articles/events in radiation biology and allied sciences, which further substantially changed the understanding in that particular research field.

4. ARTICLE OF THE ISSUE

Fukushima-derived radionuclides in the ocean and biota off Japan

Present paper published recently in *Proceedings of National Academy of Sciences, USA Vol. 109, 2012, page:* 5984-5988

Fukushima nuclear power plants accident on March 11, 2011 after Tsunami resulted in major health and environmental concerns. Present paper suggest that though Cs isotopes are elevated over prior levels in waters off Japan, radiation risks due to these radionuclides are below those generally considered harmful to marine animals and human consumers, and even below those from naturally occurring radionuclides.

Read the abstract / full article on following link: http://www.pnas.org/content/109/16/5984.full.pdf+html

(Open Access Article)

5. LITERATURE UPDATE

Radiation Biology

- Factors influencing heterogeneity of radiation induced DNA-damage measured by the alkaline comet assay http://www.ro-journal.com/content/7/1/61/abstract (Open Access)
- Effects of X-ray irradiation on methylation levels of p16, MGMT and APC genes in sporadic colorectal carcinoma and corresponding normal colonic mucosa

http://www.hccpjournal.com/content/10/S3/A12 (Open Access)

• Intestinal Microbiota as Novel Biomarkers of Prior Radiation Exposure http://www.bioone.org/doi/abs/10.1667/RR2691.1

Low dose Radiation Biology

- Modulation of inflammatory immune reactions by low-dose ionizing radiation: molecular mechanisms and clinical application. http://www.ncbi.nlm.nih.gov/pubmed/22414082.1
- No Threshold for the Induction of Chromosomal Damage at Clinically Relevant Low Doses of X Rays http://www.bioone.org/doi/abs/10.1667/RR2718.1

Radiation carcinogenesis

 Pten regulates Aurora-A and cooperates with Fbxw7 in modulating radiation-induced tumor development http://mcr.aacrjournals.org/content/early/2012/04/12/1541-7786.MCR-12-0025.abstract?papetoc

Radiation induced Bystander effect

 Ionizing radiation-induced metabolic oxidative stress and prolonged cell injury. http://www.ncbi.nlm.nih.gov/pubmed/22182453

- Microbeam Studies of Soft X-ray Induced Bystander Cell Killing Using Microbeam X-ray Cell Irradiation System at CRIEPI. http://www.ncbi.nlm.nih.gov/pubmed/22510578.1 (Open Access)
- Differential Bystander Signaling Between Radioresistant Chondrosarcoma Cells and Fibroblasts After X-Ray, Proton, Iron Ion and Carbon Ion Exposures.

http://www.ncbi.nlm.nih.gov/pubmed/22537542.1

- Comparing the level of bystander effect in a couple of tumor and normal cell lines. http://www.ncbi.nlm.nih.gov/pubmed/22557800.1
- Triphasic Low-dose Response in Zebrafish Embryos Irradiated by Microbeam Protons. http://www.ncbi.nlm.nih.gov/pubmed/22498889.1 (Open Access)
- Spatially fractionated radiation induces cytotoxicity and changes in gene expression in bystander and radiation adjacent murine carcinoma cells.

http://www.ncbi.nlm.nih.gov/pubmed/22559204.1

- Dependence of adaptive response and its bystander transmission on the genetic background of tested cells. http://www.ncbi.nlm.nih.gov/pubmed/22574641.1
- Models of the radiation-induced bystander effect. http://www.ncbi.nlm.nih.gov/pubmed/22587665.1
- Possible role of exosomes containing RNA in mediating nontargeted effect of ionizing radiation. http://www.ncbi.nlm.nih.gov/pubmed/22612287.1
- Are epigenetic mechanisms involved in radiation-induced bystander effects? http://www.ncbi.nlm.nih.gov/pubmed/22629281.1
- Non-linear response of cells to signals leads to revised characteristics of bystander effects inferred from their modelling. http://www.ncbi.nlm.nih.gov/pubmed/22640799.1

Radiation Protection

- Efficacy of Radiation Countermeasures Depends on Radiation Quality http://www.bioone.org/doi/abs/10.1667/RR2783.1
- Estimating cancer risks to adults undergoing body CT examinations http://rpd.oxfordjournals.org/content/150/2/168.abstract?etoc

Cancer Biology and Therapy

- Reactive Oxygen Species: The Achilles' Heel of Cancer Cells? http://online.liebertpub.com/doi/abs/10.1089/ars.2012.4532
- EMT and Oxidative Stress: A Bidirectional Interplay Affecting Tumor Malignancy http://online.liebertpub.com/doi/abs/10.1089/ars.2011.4280
- NADPH Oxidases as Regulators of Tumor Angiogenesis: Current and Emerging Concepts http://online.liebertpub.com/doi/abs/10.1089/ars.2011.4489
- Use of Aspirin postdiagnosis improves survival for colon cancer patients http://www.nature.com/bjc/journal/v106/n9/abs/bjc2012101a.html ?WT.ec_id=BJC-201204
- The radiation dose-regulated AND gate genetic circuit, a novel targeted and real-time monitoring strategy for cancer gene therapy http://www.nature.com/cgt/journal/v19/n6/abs/cgt201211a.html?
 WT.ec_id=CGT-201206

Cancer Radiotherapy

 Radiotherapy increases the permissiveness of established mammary tumors to rejection by immunomodulatory antibodies http://cancerres.aacrjournals.org/content/early/2012/05/08/0008-5472.CAN-12-0210.abstract?papetoc

Cancer: Prognosis and Diagnosis

• Serum concentration of iron as predictor of cancer risk among BRCA1 mutation carriers

http://www.hccpjournal.com/content/10/S3/A21 (Open Access)

• Dietary intake of meat, fruits, vegetables, and selective micronutrients and risk of bladder cancer in the New England region of the United States

http://www.nature.com/bjc/journal/v106/n11/abs/bjc2012187a.htm I?WT.ec_id=BJC-201205

- Alcohol intake and renal cell cancer risk: a meta-analysis http://www.nature.com/bjc/journal/v106/n11/abs/bjc2012136a.htm l?WT.ec_id=BJC-201205
- Activation of the AKT/cyclin D1/Cdk4 survival signaling pathway in radioresistant cancer stem cells http://www.nature.com/oncsis/journal/v1/n6/abs/oncsis201212a.ht ml?WT.ec_id=ONCSIS-201206

Technological advancement/note

- An artificially constructed radiation-responsive promoter is activated by doxorubicin http://www.nature.com/cgt/journal/v19/n5/abs/cgt20127a.html?WT .ec_id=CGT-201205
- A Modified System for Analyzing Ionizing Radiation-Induced Chromosome Abnormalities http://www.bioone.org/doi/abs/10.1667/RR2849.1

Molecular Imaging

 In vivo imaging of drug-induced mitochondrial outer membrane permeabilization at single cell resolution http://cancerres.aacrjournals.org/content/early/2012/04/14/0008-5472.CAN-11-4096.abstract?papetoc

Radiation safety

- Transfer factor of the radionuclides in food crops from high-background radiation area of south west India http://rpd.oxfordjournals.org/content/149/3/327.abstract?etoc
- Transfer coefficient of ¹³⁷Cs from feed to cow milk in tropical region Kaiga, India

http://rpd.oxfordjournals.org/content/149/3/333.abstract?etoc

- Gamma-ray thermoluminescence measurements: a record of fallout deposition in Hiroshima? http://www.springerlink.com/content/3803232637668336/
- Investigation on circular asymmetry of geographical distribution in cancer mortality of Hiroshima atomic bomb survivors based on risk maps: analysis of spatial survival data

http://www.springerlink.com/content/a743146j3201228k/

 Leukemia incidence in the Russian cohort of Chernobyl emergency workers

http://www.springerlink.com/content/3l3h322452k3l532/

- Dose-responses from multi-model inference for the non-cancer disease mortality of atomic bomb survivors http://www.springerlink.com/content/r73906m031k82714/
- Fukushima's doses tallied http://www.nature.com/news/fukushima-s-doses-tallied-1.10686
- Adverse effects of iodine thyroid blocking: a systematic review http://rpd.oxfordjournals.org/content/150/3/267.abstract?etoc

Non-ionizing radiation

- Structural basis of ultraviolet-B perception by UVR8 http://www.nature.com/nature/journal/v484/n7393/full/nature1093 1.html?WT.ec_id=NATURE-20120412
- In vitro sensitivities to UVA of lymphocytes from patients with colon and melanoma cancers and precancerous states in the micronucleus and the Comet assays

http://mutage.oxfordjournals.org/content/27/3/351.abstract?etoc

 Dosimetric investigation of the solar erythemal UV radiation protection provided by beards and moustaches http://rpd.oxfordjournals.org/content/150/3/278.abstract?etoc

6. NEWS

Nuclear Technology & Safety

Fukushima Accident and Radiation Safety

- Fukushima-derived radionuclides in the ocean and biota off Japan http://www.pnas.org/content/109/16/5984.abstract?etoc (Open Access)
- An absence of neutrinos associated with cosmic-ray acceleration in γray bursts

http://www.nature.com/nature/journal/v484/n7394/full/nature1106 8.html?WT.ec_id=NATURE-20120419

- Radiation risks: Raiders of the lost archive http://www.nature.com/news/radiation-risks-raiders-of-the-lostarchive-1.10599
- Fukushima's doses tallied http://www.nature.com/news/fukushima-s-doses-tallied-1.10686
- Fukushima—One Year Later http://rpd.oxfordjournals.org/content/149/4/353.extract?etoc
- Japan considers nuclear-free future http://www.nature.com/news/japan-considers-nuclear-free-future-1.10783

Radiation Safety

 Transfer factor of the radionuclides in food crops from high-background radiation area of south west India http://rpd.oxfordjournals.org/content/149/3/327.abstract?etoc Computed tomographies and cancer risk in children: a literature overview of CT practices, risk estimations and an epidemiologic cohort study proposal http://www.springerlink.com/content/4v7m63097738751r/?MUD=MP

Science and Society

Indian Science and Technology

- India mulling stricter laws to curb unethical trials http://www.nature.com/nm/journal/v18/n2/full/nm0212-182.html?WT.ec_id=NM-201202
- Population-based cancer incidence in Sikkim, India: report on ethnic variation

http://www.nature.com/bjc/journal/v106/n5/abs/bjc2011598a.html ?WT.ec_id=BJC-201202

Science in General

- Exercise rehabilitation in patients with cancer http://www.nature.com/nrclinonc/journal/v9/n5/abs/nrclinonc.2012
 .27.html?lang=en?WT.ec_id=NRCLINONC-201205
- Dietary intake of meat, fruits, vegetables, and selective micronutrients and risk of bladder cancer in the New England region of the United States

http://www.nature.com/bjc/journal/v106/n11/abs/bjc2012187a.htm I?WT.ec_id=BJC-201205

- Alcohol intake and renal cell cancer risk: a meta-analysis http://www.nature.com/bjc/journal/v106/n11/abs/bjc2012136a.htm l?WT.ec_id=BJC-201205
- Molecular Signature of Smoking in Human Lung Tissues http://cancerres.aacrjournals.org/content/early/2012/06/12/0008-5472.CAN-12-1160.abstract?papetoc

7. VIEWS

- Exercise rehabilitation in patients with cancer http://www.nature.com/nrclinonc/journal/v9/n5/abs/nrclinonc.2012
 .27.html?lang=en?WT.ec_id=NRCLINONC-201205
- Cancer imaging by optical coherence tomography: preclinical progress and clinical potential http://www.nature.com/nrc/journal/v12/n5/abs/nrc3235.html?lang =en?WT.ec_id=NRC-201205
- Nuclear proliferation: Time to bury plutonium http://www.nature.com/nature/journal/v485/n7397/full/485167a.ht ml?WT.ec_id=NATURE-20120510
- Fukushima's doses tallied http://www.nature.com/news/fukushima-s-doses-tallied-1.10686
- Fukushima—One Year Later http://rpd.oxfordjournals.org/content/149/4/353.extract?etoc

8. ARTICLE SERIES/REVIEWS

- Molecular mechanisms of cisplatin resistance http://www.nature.com/onc/journal/v31/n15/abs/onc2011384a.htm l?WT.ec_id=ONC-201204
- Application of Metabolic PET Imaging in Radiation Oncology http://www.bioone.org/doi/abs/10.1667/RR2702.1
- Imaging Radiation-Induced Normal Tissue Injury http://www.bioone.org/doi/abs/10.1667/RR2530.1
- A Realistic Utilization of Nanotechnology in Molecular Imaging and Targeted Radiotherapy of Solid Tumors http://www.bioone.org/doi/abs/10.1667/RR2597.1
- Application of Optical Imaging and Spectroscopy to Radiation Biology http://www.bioone.org/doi/abs/10.1667/RR2531.1
- The functions and regulation of the PTEN tumour suppressor http://www.nature.com/nrm/journal/v13/n5/abs/nrm3330.html?lan g=en?WT.ec_id=NRM-201205

- Intra-tumour heterogeneity: a looking glass for cancer? http://www.nature.com/nrc/journal/v12/n5/abs/nrc3261.html?lang =en?WT.ec_id=NRC-201205
- Nanovector delivery of siRNA for cancer therapy http://www.nature.com/cgt/journal/v19/n6/abs/cgt201222a.html? WT.ec_id=CGT-201206
- Patient-derived tumour xenografts as models for oncology drug development http://www.nature.com/nrclinonc/journal/v9/n6/abs/nrclinonc.2012 .61.html?lang=en?WT.ec_id=NRCLINONC-201206

9. RECENT BOOKS

- ICRP Publication 110 http://rpd.oxfordjournals.org/content/150/1/124.extract?etoc
- Why Millions Survive Cancer: The Successes of Science http://www.nature.com/nm/journal/v18/n6/full/nm.2766.html?WT.e c_id=NM-201206

10. LETTER(S) FROM THE READERS

• The interview with Jean Cadet is interesting and informative. Awards that were given away during these conferences should be added. -**Dr Madhu Bala**, Vice-President-ISRB, INMAS, Delhi

RADIATION SCIENCE TODAY INDIAN SOCIETY FOR RADIATION BIOLOGY

1. An Interview with Prof. Jean Cadet, France

An Interview

Radiation-induced damage to DNA: formation, measurement and biochemical processing

with

Prof. Jean Cadet (JC) Scientific Adviser, CEA/Grenoble Adjunct Professor, Medical University of Sherbrooke, France

by

Radiation Science Today (RST)

April-June

Issue: 18

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- The ISRB enewsletter is quite informative and lots of links for further reading/exploration.
 -Prof. Arun Chougule, SMS College, Jaipur
- The eNewsletter, "Radiation Science Today" is quite informative and interesting. I would say such activity is very important to popularize the nuclear messages/information and ISRB is doing a well dissemination job by publishing this eNewsletter.
 -DR. R. K. SETH. Professor & In-Charge(AERB). Department of Zoology, University of Delhi, (North

-DR. R. K. SETH, Professor & In-Charge(AERB), Department of Zoology, University of Delhi, (North Campus), Delhi-110 007 (INDIA)

11. UPCOMING CONFERENCE & WORKSHOP OF ISRB

Pre-Conference Workshop on Radiation Biology in Translational Research, ACTREC, Navi Mumbai, India

November 21, 2012

International Conference on Radiation Biology: (ICRB- 2012) and 11th Biennial Meeting of Indian Society for Radiation Biology Theme: Cosmic Radiation to Cancer Therapeutics Advanced Centre for Training, Research and Education on Cancer (ACTREC), Navi Mumbai, Mumbai, India

November 22-24, 2012

Conference Secretariat:

Advanced Centre for Treatment, Research and Education in Cancer, Tata Memorial Centre, Kharghar Sector 22, Navi Mumbai, 410210, India

Phone: +91-22-27405075

Fax: +91-22-27405080

Email: ICRB2012@gmail.com

For updated information visit web page:

www.icrb2012.org or

http://www.isrbindia.com/upcoming-events-of-the-society/

Post Conference Satellite International Conference on Radiation and Cancer, Nehru Gram Bharati University (NGBU), Allahabad, India

November 26-27, 2012

Contact Person:

Dr K. P. Mishra (Conference Chairman)

Vice Chancellor

Nehru Gram Bharati University

Allahabad 211 002 India

Mobile: +91-9320466999/9838737787

Tel. +91-532-6453999 Fax 91-532-2468700

Email: vc.ngbu@gmail.com,

mishra_kaushala@rediffmail.com

12. UPCOMING MEETINGS / WORKSHOPS

• 2012 AACR/ASCO Workshop: Methods in Clinical Cancer Research, July 28-Aug. 3, 2012, Colarado, USA

http://www.vailworkshop.org/

 Cell Symposia Human Immunity, August 19 - 21, 2012, Sheraton Lisboa, Lisbon, Portugal

http://www.cell-symposia-human-immunity.com/index.html

- 37th ESMO Congress, Vienna, Austria, September 28 October 2, 2012 http://www.esmo.org/events/vienna-2012-congress/abstract-submission.html
- Pre-Conference Workshop on Radiation Biology in Translational Research, ACTREC, Navi Mumbai, India, November 21, 2012

Conference Secretariat:

Advanced Centre for Treatment, Research and Education in Cancer, Tata Memorial Centre, Kharghar Sector 22, Navi Mumbai, 410210, India

July-September	Issue: 19	Year: 2012	20
July September	issue: is	1Cull 2012	20

Phone: +91-22-27405075

Fax: +91-22-27405080

Email: ICRB2012@gmail.com

Web page: www.icrb2012.org

• International Conference on Radiation Biology: (ICRB- 2012) and 11th Biennial Meeting of Indian Society for Radiation Biology, Theme: Cosmic Radiation to Cancer Therapeutics, Advanced Centre for Training, Research and Education in Cancer (ACTREC), Navi Mumbai, Mumbai, India, November 22-24, 2012

Conference Secretariat:

Advanced Centre for Treatment, Research and Education in Cancer, Tata Memorial Centre, Kharghar Sector 22, Navi Mumbai, 410210, India

Phone: +91-22-27405075

Fax: +91-22-27405080

Email: ICRB2012@gmail.com

Web page: www.icrb2012.org

 Post Conference Satellite International Conference on Radiation and Cancer, Nehru Gram Bharati University (NGBU), Allahabad, India November 26-27, 2012

Contact Person: Dr K. P. Mishra (Conference Chairman) Vice Chancellor Nehru Gram Bharati University Allahabad 211 002 India **Mobile:** +91-9320466999/9838737787 **Tel.** +91-532-6453999 Fax 91-532-2468700 **Email:** vc.ngbu@gmail.com, mishra_kaushala@rediffmail.com

 National Summit on Frontiers of Biophysics, Biotechnology & Bioinformatics, Jan 13-16, 2013, Department of Biophysics and Centre for Excellence in Basic Sciences, University of Mumbai

Contact Person: Dr P M Dongre, Head, Department of Biophysics, University of Mumbai, Vidyanagari Santacruz (E), Kalina, Mumbai 400098. Email: ibs2013@mu.ac.in; ibs2013mu@gmail.com

http://mu.ac.in/science/bio_physics/ibs2013/ifr.htm

July-September	r
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Important Notice: Are you organizing any Workshop/Meeting related to Radiation Research or in related research areas? You can add the announcement of event to this eNewsletter **free of cost**!! The announcement would reach to ISRB Community as well many more in India and abroad. The details of announcement may be communicated to:

isrb_enewsletter@yahoo.co.in. Moreover, the information would be included to web page as and when it would be available.

13. AWARDS/HONORS TO ISRB MEMBERS

Name of the ISRB Member	Affiliation	Award/Honors	Year/ Period
Dr Pankaj Kumar Joshi	Radiation Biology Laboratory, Department of Zoology, Govt. Dungar College, Bikaner, India	YOUNG SCIENTIST AWARD International conference on Immerging Frontiers and challenges in radiation biology, Bikaner	Jan. 2012
DR. S. P. Mishra	Kamla Nehru Hospital, Allahabad	Delivered " Prof N. C. Singhal Oration " during XVI Annual Scientific Convention Association of Medical Physicist of India. North Chapter (AMPINC) held at New Delhi, Apr 06-07, 2012	April 2012

Congratulations to the Life Members of Indian Society for Radiation Biology for prestigious Awards and Honors!!

We wish many more in future!!

14. RECENT PUBLICATIONS/PATENTS OF ISRB MEMBERS

Author/Affiliation	Title	Citation	Key words
A. Berni, R. Grossi,	Protective effect	Mutat. Research 746	
<u>A. T. Natarajan, F. Palitti*</u>	of ellagic acid	(2012) 60-65.	
Department of Ecological	(EA) on the		
and Biological Sciences,	formation of		
Università degli Studi della	micronuclei		
Tuscia, Largo	induced by MNNG		
dell'Università, Viterbo,	in mammalain		
Italy.	cells in in vitro		
*Email: palitti@unitus.it	assays and in		
	vivo.		
<u>A.T.Natarajan</u>	Reflections on a	Mutat. Res: Rev. Mutat.	
Visiting Professor,	life time in	Res.751 (2012) 1-6.	
Department of Ecological	Cytogenetics.		
and Biological Sciences,			

University of Tuscia, Largo dell. universita. s.n.c. 1- 0100 Viterbo, Italy. Email: natarajan@live.nl			
Sharma Ramakant ^{1*} and R K Purohit1 Radiation Biology Laboratory, Department of Zoology, Govt. Dungar College, Bikaner, India *Corresponding Author: Sharma Ramakant, Email: ramakant_sharma10@yaho o.com	Protective role of Liv52 against radiation and cadmium induced haematological changes in Swiss Albino mice	Int. J. LifeSc. Bt & Pharm. Res. 2012	Radiation, Cadmium, Liv52, Blood, Mice
L. Ramachandran ¹ and C.K.K. Nair ^{2*} ¹ Amala Cancer Research Centre, Thrissur 680555, Kerala, India ² Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla 689101, Kerala, India E-mail: ckknair@yahoo.com	Radioprotection by tempol: Studies on tissue antioxidant levels, hematopoietic and gastrointestinal systems, in mice whole body exposed to sub- lethal doses of gamma radiation	Iran. J. Radiat. Res., 2012; 10(1): 1-10	Antioxidant defense, radioprotector, hematopoietic system, gastrointestinal mucosa, spleen colony, tempol.

15. CAREER FORUM

Grants and Awards

- Looking for Grants, Funds, Fellowships related to Radiation Research, visit the Radiation Research Web page or following link http://www.radres.org/ECOMradres/timssnet/common/tnt_JobsFundinga ndFellowships.cfm
- Pre- and Post Doctoral Fellowships from NIH http://grants.nih.gov/training/extramural.htm
- AACR-Gertrude B. Elion Cancer Research Award http://www.aacr.org/default.aspx?p=3859
- AACR Career Development Awards

http://www.aacr.org/default.aspx?p=3858

• AACR seeks nominations of outstanding scientists for prestigious Landon-AACR Prizes for Basic & Translational Cancer Research.

Call for nominations now open through August 25, 2008 For information, visit http://www.aacr.org/page13893.aspx

- Science Foundation Ireland, (SFI)
 The national foundation for excellence in scientific research is investing in academic researchers and research teams who are most likely to generate new knowledge, leading edge technologies, and competitive enterprises.

 www.sfi.ie
- Pancreatic cancer research centre funding over 2 million dollars
 Please view individual grant mechanisms for eligibility and deadlines.
 Grants provide funding for outstanding pancreatic cancer research.

http://www.aacr.org/home/scientists/research-funding--fellowships.aspx

- AACR, Research Funding & Fellowships
 http://www.aacr.org/home/scientists/research-funding--fellowships.aspx
- Biomedical Research Fellowship Programme for India (Wellcome Trust/DBT India)

http://www.wellcomedbt.org/

Article related to career issues

- Education: The PhD factory http://www.nature.com/news/2011/110420/full/472276a.html?WT.ec_id= NATURE-20110421
- Education: Rethinking PhDs http://www.nature.com/news/2011/110420/full/472280a.html?WT.ec_id= NATURE-20110421
- Seven ages of the PhD http://www.nature.com/nature/journal/v472/n7343/full/472283a.html?W T.ec_id=NATURE-20110421
- Developing world: Educating India http://www.nature.com/news/2011/110405/full/472024a.html?WT.ec_id= NATURE-20110407

 Postdoctoral training: Time for change http://www.nature.com/ncb/journal/v13/n7/full/ncb0711-735a.html?WT.ec_id=NCB-201107

Important Web Sites

- AACR Research Fellowships http://www.aacr.org/default.aspx?p=3860
- **GrantsNet** is resource to find funds for training in the sciences and undergraduate science education. Through the support of HHMI and AAAS, this service is completely free.

http://www.grantsnet.org/start.cfm?session_id=844615

• **Naturejobs** the career magazine from Nature with the hottest science jobs and details of career related issues.

http://www.nature.com/naturejobs/index.html

 Post Doc Jobs, a site providing opportunities about Post Doc Jobs. It is a platform to bring students, Professionals and Research Institutes together.

http://www.postdocjobs.com/

• Science's Next Wave is a weekly online publication that covers scientific training, career development, and the science job market. Next Wave is published by SCIENCE magazine and the American Association for the Advancement of Science.

http://nextwave.sciencemag.org/?CFID=789744&CFTOKEN=78870222

- The National Academy of Sciences offers Research Associateship Awards to doctoral level scientists and engineers (US and foreign nationals). For more information go to http://sites.nationalacademies.org/pga/RAP/index.htm
- Science careers

http://sciencecareers.sciencemag.org/tools_tips/outreach/relationships_bo oklet

Important Notice: If you have any vacancy in your laboratory/Institute, you can advertise the post through this eNewsletter. In addition, any award in these fields may be also announced. **It is absolutely free!!** The advertisement would reach to Members of ISRB and many more, who may be interested about the vacancy. The details of vacancy may be communicated to: **isrb_enewsletter@yahoo.co.in**.

16. USEFUL LINKS

http://www.isrbindia.com/eNewsletter/useful-links/

17. IMPORTANT JOURNALS

http://www.isrbindia.com/eNewsletter/journals-links/

18. NEW LIFE MEMBERS OF ISRB

Warm welcome to New Life Members of ISRB !!!

S. N.	Name Affiliation		Research
			Interest/Expertise
1.	Ms. Amritha M.	Dept. of Biophysics, Mumbai	Radiation Biophysics,
	Joshi <i>(ISRB/J-15/206)</i>	University, Kalina, MUMBAI 400098, INDIA	Radiation protection
2.	Prof. P. M. Dongre	Prof. and Head, Dept. of Biophysics,	Radiation Biophysics,
	(ISRB/D-10/013)	Mumbai University, Kalina, MUMBAI 400 098, INDIA	Radiation protection
3.	Shri Damodar K. M	Department of Physiology, K.G.	Radiation Biology
	Gowda (ISRB/G-20/039)	Hegde Medical Academy, Deralakatte, MANGALORE-18 INDIA	
4.	Shri Shrikant L.	Department of Physiology, K.G.	Radiation Biology
	Patil	Hegde Medical Academy, Deralakatte,	
	(ISRB/P-10/208)	MANGALORE-18, INDIA	
5.	Ms. K. B. Kalpana	Department of Biochemistry and	Radiation Biology
	(ISKD/K-IS/200)	ANNAMALAI NAGAR, 608 002, Tamil	
		Nadu, INDIA	
6.	Prof. Shyam	Prof. and Head, Department of	Radiation oncology
	Kishore Srivastava	Radiation Oncology, TMH, Parel,	
	(ISRB/S-59/233)	MUMBAI 400 012, INDIA	
/.	Dr Umesn Mabantshotty	Department of Radiation Uncology,	Radiation oncology
	(ISRB/M-13/207)	Borges Street Parel MIMBAI -	
	(15)(D)(1)(207)	400012, INDIA	

19. NOTICE BOARD

Update your email and contact address

Dear Members of ISRB,

The eNewsletter would be send to ISRB Members by email only. If your email address is getting changed or you have any other preferred email, please communicate to us as soon as possible on **isrb_enewsletter@yahoo.co.in**. In case, any other ISRB Member, who is not receiving eNewsletter, please intimate us his/her email address.

In addition, if any other friend or colleague is interested to receive the eNewsletter, please let us know his/her email address to be included in our mailing list. The eNewsletter is free to ISRB Members as well as non-Members too. **The subscription of eNewsletter is absolutely free!!!**

In addition, it is frequent problem to communicate with ISRB members due to change in address. If your contact address has been changed please intimate to Secretary, ISRB. This would help us to reach you and communicate, when ever needed.

• Join ISRB

Are you/your colleague/friend working in Radiation Research or related field and still not a Member of Indian Society for Radiation Biology? Join ISRB.

As Member of ISRB, (a) you would join with scientific community working in Radiation Research and related research areas. (b) You are entitled to participate in Meeting/Workshops of ISRB at reduced Registration Fee (c) Your interaction with Scientists and experts from India and abroad would help in your career.

To be a Member of ISRB, fill the attached application form (in last of eNewsletter) along with along with Membership fee to Secretary, ISRB. For details, contact Secretary or any of the Office Bearers of ISRB as given below.

The application form can be downloaded from the web page: **www.isrbindia.com** or click on following link:

http://www.isrbindia.com/assets/Uplaods/ISRB-Membership-Application-Form.doc (MS Word Version)

http://www.isrbindia.com/assets/Uplaods/ISRB-Membership-Application-Form.pdf (PDF Version)

• Awards / Honors to ISRB Members

Editorial Board **`Radiation Science Today'** is pleased to launch a column "**AWARDS/HONORS to ISRB Members**" in the eNewsletter. We hope the column would make us more aware with each other about our awards/ scientific achievements.

This column is only for Members of Indian Society for Radiation Biology. If you are Member of ISRB and received any award or scientific honour, you are requested to send details of same in following format on email address: isrb_enewsletter@yahoo.co.in, with subject line: Awards/Honors.

To avoid the verification of Membership and any ambiguity from non-ISRB Members, a line of statement is requested that 'I am a Member / Life Member of Indian Society for Radiation Biology'.

Details of award or scientific recognition can be submitted in prescribed format provided below as when received, which would be included in next upcoming issue of the eNewsletter.

Please circulate the announcement to your colleagues and friends, who are Members of ISRB. Please provide complete information to avoid unnecessary delay in publication in eNewsletter.

Name and Present Address of ISRB Member	Affiliation (if any)	Name of Award/Honor	Year/Period

Statement: I am Member/Life Member of Indian Society for Radiation Biology.

Name of the ISRB Member:

• Recent publications/patents of ISRB Members

Dear Members of ISRB,

It is our pleasure to mention that in last two years, '**Radiation Science Today**' the eNewsletter published by Indian Society for Radiation Biology, has made a significant contribution to link the Members of Society working in various research fields of radiation biology and allied sciences. To further strengthen the interaction amongst Members of ISRB, we have initiated a new Column '**Recent Publications of ISRB Members' beginning** from issue of eNewsletter i.e. **Jan-March**, **2010 Issue 9**.

The publication/patents meeting following criteria would be included in the eNewsletter:

1. At least one author of citation should be Life Member of ISRB.

2. Citations only with final page number should be provided i.e. 'In Press' citations would not be considered.

3. It should be published in National/International Journals or Book/Book Chapters. No abstract or Conference Proceedings would be considered.

4. Names of ISRB Members names should be bold and underlined. The authors may provide maximum five key words. The email address of corresponding authors should be provided so that interested may contact to seek some clarification or to receive reprints.

5. Members should provide full citation(s) as and when it would be made available in the required format.

All ISRB Members are requested and encouraged to submit their recent publication(s) in format provided with **Subject Head line: Publication.** A copy of the format is provided below for your reference.

You may communicate the message to other ISRB members, if they could not receive this communication.

Authors/Affiliation/Email	Title	Citation	Key Words
Kumar A, Ali M, Mishra P, Pandey BN, Sharma P, <u>Mishra</u> <u>KP</u> . Email: mishra_kaushala@rediffmail.com Radiation Biology and Health Sciences Division, Bhabha Atomic Research Centre, Mumbai - 400085, India	Thorium-induced neurobehavioural and neurochemical alterations in Swiss mice.	International Journal of Radiation Biology, 2009, 85(4):338-347.	Thorium Toxicity; Neurobehavioral, neurochmeical alterations; oxidative injury
Hazra B ¹ , <u>Pandey BN</u> , Kumar A, Ghosh S ¹ , Kumar B ¹ , <u>Mishra KP</u> Email: banasrihazra@yahoo.co.in Radiation Biology and Health Sciences Division, Bhabha Atomic Research Centre, Mumbai - 400085, India ¹ Department of Pharmaceutical Technology, Jadavpur University , Kolkata , India	Plant Products in modification of cellular damage by radiation: Implications in cancer radiotherapy.	In "Herbal Drugs: A Cancer Chemopreventive and Therapeutic Perspective" (Ed.: R. Arora, INMAS, New Delhi), Publisher: Jaypee Brothers Medical Publishers, New Delhi , 2009	Cancer radiotherapy; Natural Plant Products; Apoptosis

• You can contribute in this eNewsletter

You can send your contribution, which may be included in this eNewsletter under 'Reader's Column'

Brief scientific article (maximum 1000 words, if reference needed, in 'International Journal of Radiation Biology' style) may be submitted for publication in eNewsletter. Your article may fall under following subject category: (i) radiation sciences or related research areas; (ii) your opinion on any scientific issue, technique or some general topics; (iii) any major finding or research concept from the archives of radiation sciences. The article should be original. It would be published in eNewsletter after general screening/reviewing of the article by the Editorial Board.

For any further clarification or submission of any article write to Editor on email address: isrb_enewsletter@yahoo.co

In addition, if you come across any recent journal / books published in radiation and related research areas, please send us the details of the book/journal on our email: isrb_enewsletter@yahoo.co. The details of books/journal would be included in the eNewsletter **free of cost**!!!

EDITORIAL BOARD "RADIATION SCIENCE TODAY" ENEWSLETTER				
	AFFLIATION	EMAIL/TEL.		
Dr. B. N. Pandey (Editor)	Radiation Biology and Health Sciences Division, Bhabha Atomic Research Centre, Mumbai 400 085	badrinarain@yahoo.co.in, bnp@barc.gov.in +91-22-2559 5043 (Work) +91-22-2555 7605 (Res.) +91-986 987 2243 (M)		
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Prof. P. K. Goyal (Member)	Department of Zoology, Rajasthan University, Jaipur	pkgoyal2002@rediffmail.com		
eNewsletter email: isrb_enewsletter@yahoo.co.in				

Web page: www.isrbindia.com/eNewsletter/

INDIAN SOCIETY FOR RADIATION BIOLOGY Executive Council (2011-13)

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(Vice President)	Allied Sciences Brig. S. K. Mazumdar Marg, Delhi, India
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Published by:

INDIAN SOCIETY FOR RADIATION BIOLOGY

(Reg. No. S-19927, dt. May 5, 1989)

Head Office: Institute of Nuclear Medicine & Allied Sciences, Lucknow Marg, Delhi-110 054 (INDIA)

Tel: +91-11-2942418, 2940667 Fax: +91-11-2919509 Web page: **www.isrbindia.com**

We hope you will find this Newsletter as a useful resource of information. However, we look forward for your active contribution and valuable comments/ suggestions for improvement of the eNewsletter on **isrb_enewsletter@yahoo.co.in** or any of the Member of Editorial Board.

Disclaimer: You are being sent the eNewsletter since either you are member of Indian Society for Radiation Biology or identified as potential reader of the eNewsletter. If you wish to discontinue receiving the eNewsletter in future write to us: isrb_enewsletter@yahoo.co.in.

Every effort has been taken to provide up-to-date and correct information in the Newsletter. However, readers are advised to check the related source of information.

Editorial Board

INDIAN SOCIETY FOR RADIATION BIOLOGY

(Regd. No. 5-19927, dt. May 5, 1989)

H.O.: Institute of Nuclear Medicine & Allied Sciences, Lucknow Road, New Delhi-110 054 Web page: www.isrbindia.com

	Application for Membership				
To Sec Ind	Fo: Affix your Secretary passport size Indian Society for Radiation Biology (ISRB) photo here				
I w bel	rish to apply for Life Mem ow:	bership for tl	he Indian Society for Radiation Biology. My	particulars are given	
1.	Full Name (Block Letters	5)			
2.	Present Position/Title				
3.	Date of Birth				
4.	Academic qualifications: Year	<u>Degree</u>	University		
-					
5.	Field of Specialization				
6.	. Research Interest				

7.	Address:	Official:
		TelFax: E-mail
		Permanent
8.	Life Me Bank tra	mbership fee : Rs 2000.00 Foreign members: US\$ 200 nsfer/Draft/Cheque NoDate:Drawn on Bank
(No	ote: Outsta	tion cheques would not be accepted. DD should be payable at Mumbai or Delhi.)
Pla	ce:	Date: Signature:
Pro	posed by .	
Sec	conded by	Membership No. and Signature

For Use of ISRB Secretariat Only

Membership No.	Type of Membership	
Membership approved/not	pproved by Executive Council in its meeting held	
on		
Payment received vide	on	
Secretary/Treasurer:		

President, Indian Society for Radiation Biology

Please mail the Application for Membership along with recent passport size photographs to: Dr B. N. Pandey, Secretary, ISRB, Radiation Biology and Health Sciences Division, Bhabha Atomic Research Centre, Mumbai 400 085, India. E-mail: isrbindia@yahoo.in; badrinarain@yahoo.co.in